



CE Linux Forum

Experiences with OpenEmbedded and the OMAP5912 Starter Kit

Stephen Johnson

Panasonic Digital Networking Laboratory

June 13th, 2005



Overview

- OMAP5912 Starter Kit
- OpenEmbedded
- Problems and solutions
- Evaluation
- Resources
- Conclusions



Disclaimer

- I am not an expert.
- Nothing is claimed to be optimal.
- This talk is a chronicle of what I did to get OpenEmbedded running on an OSK with a LCD module.



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OMAP 5912 Starter Kit (OSK)



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OSK – Back Side



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OSK Hardware Features

- Texas Instruments TMS320C55xx core operating at 192 Mhz
- ARM9 core operating at 192 Mhz
- TLV320AIC23 codec
- 32 Mbyte DDR RAM
- 32 Mbyte on board Flash ROM
- 4 Expansion connectors (bottom side)
- RS-232 serial port
- 10 MBPS Ethernet port
- USB port



OSK Hardware Features (cont'd)

- On board IEEE 1149.1 JTAG connector for optional emulation
- +5 Volt operation only, power supply included
- Size: 5.55" x 3.54" (141 x 90 mm), 0.062 thick, 8 layers
- Compatible with Spectrum Digital's OSK wire Wrap Prototype Card



Software Features

- Compatible with MontaVista's Linux for OSK5912
- Compatible with OMAP Code Composer Studio from Texas Instruments



What's Included

- OMAP5912 OSK board
- MontaVista Linux for OMAP5912 OSK
- Null modem RS-232 cable
- Ethernet cable
- AC Power cord and Power supply
- Quick Start Guide
- The flash is preloaded



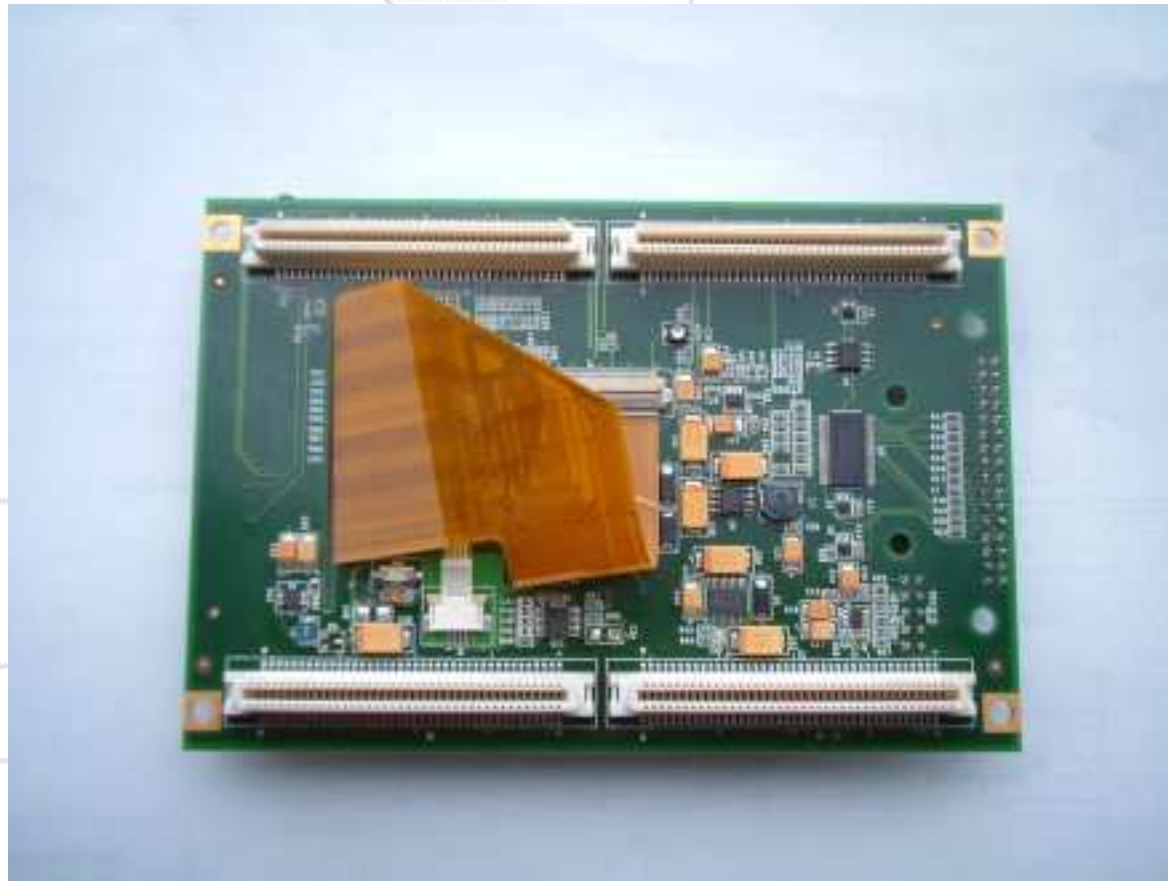
Q-VGA LCD Module



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Q-VGA LCD Module – Back Side





Description

- A plug-in for the OMAP5912 OSK
- NEC QVGA 3.5" LCD display and touch screen
- 4 user defined buttons
- 5 position joystick button
- Dual function camera port



What's Included

- QVLM module
- Stylus
- Drivers
- Documentation



OpenEmbedded Overview

- Tools to generate
 - Tool chain
 - Different distributions
 - Different user level GUIsfor different boards
- Everything is controlled by a “package”



OpenEmbedded Packages

- Package is described by a meta file
 - Dependencies between packages
 - Required patches
 - URLs for source and patches
 - How to build and install the package
 - ...
- Build packages with “bitbake”
 - Written in python



Distributions

- Familiar
- OpenZaurus
- OpenOmap
- Openslug, nylon, ...
- Look in `openembedded/conf/distros` for others



User Level GUIs

- Opie (Open Palmtop Integrated Environment)
 - Based on qt libraries
 - www.trolltech.com
- Gpe
 - Based on X11 libraries
 - GTK+ widgets
 - <http://www.gtk.org/>



OpenEmbedded Directory Structure

- Main ones you'll use (under build/tmp)
 - work - where all the work is done, sources
 - stamps - time stamps for the operations
 - rootfs - root file system, suitable for NFS mounting
 - deploy - images and package files (ipk format)
 - temp - in package subdirectory under work directory is where the log files are
- Others
 - cache
 - cross
 - staging



Boot OSK

- Connect ethernet and serial cables
- On Linux host

```
$ minicom -w
```
- Power up OSK
- Hit a key in minicom to stop booting process
- Oh no, prompt: OMAP1610 Innovator #



First Problem

- Need to get new version of u-boot
- Not really difficult to fix – just do normal Opie build
- Builds new u-boot and we will then update the flash
- More on this later



Set Up U-Boot

- Change IP info in u-boot

```
OMAP1610 Innovator # printenv
baudrate=115200
ipaddr=156.117.97.156
serverip=156.117.97.139
netmask=255.255.254.0
bootargs=console=ttyS0,115200n8 noinitrd ...
bootcmd=bootm 0x100000
bootfile=uImage
bootdelay=10
stdin=serial
stdout=serial
stderr=serial
```



Set Up U-Boot (cont'd)

- Linux host IP address: 192.168.1.10
- MAC address on OSK: 00:0e:99:02:07:a4
- Desired OSK IP address: 192.168.1.102
- More details at

<http://www.capgo.com/Resources/SoftwareDev/osk-newbie-guide.pdf>



Set Up U-Boot (cont'd)

```
OMAP1610 Innovator # setenv ethaddr 00:0e:99:02:07:a4
OMAP1610 Innovator # setenv ipaddr 192.168.1.102
OMAP1610 Innovator # setenv serverip 192.168.1.10
OMAP1610 Innovator # setenv netmask 255.255.255.0
OMAP1610 Innovator # printenv
baudrate=115200
bootargs=console=ttyS0,115200n8 noinitrd rw ip=off ...
...
ipaddr=192.168.1.102
serverip=192.168.1.10
netmask=255.255.255.0
ethaddr=00:0e:99:02:07:a4
```

```
Environment size: 279/131068 bytes
```



Set Up U-Boot (cont'd)

- Save changes

```
OMAP1610 Innovator # saveenv  
Saving Environment to Flash...  
Un-Protected 1 sectors  
Erasing Flash...  
Erasing sector 1 ... done  
Erased 1 sectors  
Writing to Flash...
```



U-Boot Problem Is Waiting

- There is a bug in the pre-installed version of u-boot
 - OSK may hang after decompressing the kernel
- Two solutions
 - Upgrade u-boot
 - Modify and recompile the kernel



Get Started with OpenEmbedded

- Check/install required software on GettingStarted wiki page
 - <http://www.openembedded.org>
- Download svn
 - <http://subversion.tigris.org/>
- Create a directory for bitbake and install it
 - `mkdir $HOME/src/bitbake`
 - `cd $HOME/src/bitbake`
 - `svn co svn://svn.berlios.de/bitbake/trunk/bitbake`
- Potential problem
 - svn.berlios.de doesn't allow http access



Getting Started (cont'd)

- Download OpenEmbedded

```
$ cd $HOME/src/oe  
$ mkdir build  
$ bk clone \  
    http://openembedded.bkbits.net/openembedded  
$ cd openembedded  
$ bk -r co -q
```

- Size ~ 235MB



Configuration

- Make config file

```
$ cd $HOME/src/oe/build
```

```
$ mkdir conf
```

```
$ cp ../openembedded/conf/local.conf.sample \
  conf/local.conf
```

- Edit build/conf/local.conf – read the file as you edit it (there will be a test!)

- DL_DIR – download directory
- BB_FILES – where the bitbake “meta” files are
- TMPDIR – where all the work goes
- MACHINE – omap5912osk
- DISTRO – openomap



Machines

akita.conf
beagle.conf
boxer.conf
c7x0.conf
colinux.conf
collie.conf
corgi.conf
epia.conf
geodegx.conf
h3600.conf
h3900.conf
handheld-common.conf
husky.conf
ipaq-common.conf
ipaq-pxa-2.6.conf
jornada56x.conf
jornada6xx.conf
jornada7xx.conf
lite5200.conf
mainstone.conf

mtx-1.conf
native.conf
netvista.conf
nslu2.conf
omap1510inn.conf
omap1610h2.conf
omap1710h3.conf
omap2420h4.conf
omap5912osk.conf
poodle-2.4.conf
poodle-2.6.conf
poodle.conf
ramses.conf
SCCS
shepherd.conf
simpad.conf
spitz.conf
sun4cdm.conf
thinclient-common.conf
tosa-2.4.conf

tosa-2.6.conf
tosa.conf
tune-arm920t.conf
tune-arm926ejs.conf
tune-c3.conf
tune-ppc603e.conf
tune-ppce500.conf
tune-sh3.conf
tune-sh4.conf
tune-strongarm.conf
tune-xscale.conf
vibren-pxa255idp.conf
wl500g.conf
wrt54.conf
x86.conf
x86-uml.conf
xxs1500.conf
zaurus-clamshell-2.4.conf
zaurus-clamshell-2.6.conf
zaurus-clamshell.conf



Distributions

asusoe.conf	openslug.conf
colinuxoe.conf	openzaurus-3.5.2.conf
familiar-0.8.0.conf	openzaurus-3.5.3.conf
familiar-0.8.1.conf	openzaurus-3.5.4.conf
familiar-0.8.2.conf	openzaurus.conf
familiar-0.9.0.conf	preferred-e-versions.inc
familiar.conf	preferred-gpe-versions-2.6.inc
generic.conf	preferred-gpe-versions.inc
jlime.conf	preferred-opie-versions.inc
nylon.conf	sharprom-compatible.conf
openmnci.conf	switchbox.conf
openomap.conf	unslung.conf
opensimpad-0.9.0.conf	wrt54oe.conf



Build OpenEmbedded

```
$ cd $HOME/src/oe/build
```

```
$ bitbake opie-image
```

```
NOTE: Using cache in '/h.../build/tmp-omap5912osk/cache'
```

```
NOTE: Parsing finished. 2316 cached, 0 par ... 0 masked.
```

```
NOTE: Building provider hash: [#####...##] (100%)
```

```
NOTE: build 200506031402: started
```

OE Build Configuration:

```
TARGET_ARCH      = "arm"
```

```
TARGET_OS        = "linux"
```

```
MACHINE          = "omap5912osk"
```

```
DISTRO           = "openomap"
```

```
TARGET_FPU       = "soft"
```

```
...
```

June 13th, 2005



The Problems Start

```
NOTE: package uboot-0.0cvs20050... do_compile: started
ERROR: function do_compile failed
ERROR: log data follows (/home/pesos/src/oe/build/tmp\
-omap5912osk/work/uboot-0.0cvs20050520-r2/temp/log.do_\
compile.31040)
| NOTE: make CROSS_COMPILE=arm-linux- omap5912osk
| make: *** No rule to make target `omap5912osk'. ...
| FATAL: oe_runmake failed
NOTE: Task failed:
NOTE: package uboot-0.0cvs20...task do_compile: failed
ERROR: TaskFailed event exception, aborting
NOTE: package uboot-0.0cvs20050520: failed
ERROR: Build of opie-image failed
```



U-Boot Solution

- In openembedded/packages/uboot/uboot_cvs.bb change

```
UBOOT_MACHINE ?= "${MACHINE}"
```

to

```
UBOOT_MACHINE ?= "${MACHINE}_config"
```

- In work/uboot-0.0cvs20050520-r2/uboot/include/configs/omap5912osk.h add (by

```
#define for CFG_MALLOC_LEN)
```

```
- #define CFG_GBL_DATA_SIZE 128
```



U-Boot Solution (cont'd)

- Edit `.../work/uboot-0.0cvs20050520-r2/u-boot/cpu/arm926ejs/config.mk`
 - Delete short-load-bytes
 - Delete apcs-32
 - -m parameters for arm processor
 - This solution depends on the gcc version



Example of Finding Solution

```
netconsole.c ns16550.c ... ks8695eth.c > .depend
| ks8695eth.c:27:31: asm/arch/platform.h: No such \
file or directory
| make[1]: *** [.depend] Error 1
| make[1]: Leaving directory `/home/pesos/src/oe/build\
/tmp-omap5912osk/work/uboot-0.0cvs20050523-r2/u-boot\
/drivers'
| make: *** [drivers/libdrivers.a] Error 2
| FATAL: oe_runmake failed
NOTE: Task failed:
NOTE: package uboot-0.0cvs20050523-r2: task do_compile:\
failed
ERROR: TaskFailed event exception, aborting
NOTE: package uboot-0.0cvs20050523: failed
ERROR: Build of opie-image failed
```



Solution Example (cont'd)

```
$ cd .../work/uboot-0.0cvs20050523-r2/u-boot  
$ find . -name platform.h  
./include/asm-microblaze/platform.h  
./include/asm-arm/arch-ks8695/platform.h
```

Error message was from

ks8695eth.c:27:31: asm/arch/platform.h

Edit u-boot/drivers/ks8695.c:

change

```
#include <asm/arch/platform.h>
```

to

```
#include <asm-arm/arch-ks8695/platform.h>
```




Kernel Build Error

```
NOTE: package linux-omap1-2.6.12-... do_package: completed
NOTE: package linux-omap1-2.6.12-... task do_deploy: started
ERROR: function do_deploy failed
ERRO...work/linux-omap1-2.6.12-rc2/temp/log.do_deploy.14073)
| Image Name:      OE
| Created:         Mon May 23 09:48:27 2005
| Image Type:      ARM Linux Kernel Image (gzip compressed)
| Data Size:       996832 Bytes = 973.47 kB = 0.95 MB
| Load Address:  0x10C08000
| Entry Point:    0x10C08000
| cp: cannot create regular file `/tftpboot/uImage_bb.cc': \
Permission denied
NOTE: Task failed:
NOTE: package linux-omap1-2.6.12-rc2: task do_deploy: failed
ERROR: TaskFailed event exception, aborting
NOTE: package linux-omap1-2.6.12: failed
```



Kernel Solution

- Compile has completed
- Looks like it's trying to write kernel image to /tftpboot
- That's not the place I put my images!
- deploy is a meta operation (in a .bb file)
 - Kernel packages are in openembedded/packages/linux
 - There is a linux-omap1_2.6.12-rc2.bb
 - Aside: there are 68 different kernel entries in directory



Kernel Solution (cont'd)

- A “grep tftpboot *.bb” verifies that linux-omap1_2.6.12-rc2.bb is the only file
- During the edit to fix /tftpboot, it seems that things are being put in `${DEPLOY_DIR}` instead of `${DEPLOY_DIR}/images` where they belong. So
 - Change `${DEPLOY_DIR}` to `${DEPLOY_DIR}/images` (if appropriate)
 - Change /tftpboot to where ever you keep kernel images to boot



Bad Value for -mtune

- At some point (this one happened during build of udev) you might get the following error during a compile:

```
udev.c:1: error: bad value (arm926ejs) for  
-mtune= switch
```



-mtune Solution

- In openembedded/conf/machine/tune-arm926ejs.conf change

```
TARGET_CC_ARCH = "-march=armv5te -mtune=arm926ejs"
```

to

```
TARGET_CC_ARCH = "-march=armv5te -mtune=arm926ej-s"
```

- Note: this is dependent on compiler version
- Can be found by doing a “man gcc” and looking at the “Arm Options” under “Hardware Models and Configurations” (it’s way, way down the man page)



What Next?

- Eventually, it finishes
- In the process the following have been built:
 - u-boot image
 - kernel image
 - root file system image (jffs2)
 - root file system suitable for NFS mounting



Updating U-Boot

- Before we can update u-boot, we need to copy the new u-boot image from `build/tmp/ deploy/images` to our “tftpboot” directory

```
cp build/tmp-omap5912osk/deploy/images/u-boot-  
omap5912osk-20050511192010.bin /home/pesos/images/
```



Updating U-Boot (cont'd)

```
OMAP1610 OSK # tftpboot 10000000  
/home/pesos/images/u-boot-omap5912osk-  
20050511192010.bin  
Using MAC Address 00:0E:99:02:07:A4  
TFTP from server 192.168.1.10; our IP address is  
192.168.1.102  
Filename '/home/pesos/images/u-boot-omap5912osk-  
20050511192010.bin'.  
Load address: 0x10000000  
Loading: #####  
done  
Bytes transferred = 87424 (15580 hex)  
OMAP1610 OSK #
```




Updating U-Boot (cont'd)

```
OMAP1610 Innovator # protect off 0 1FFFF
```

```
.
```

```
Un-Protected 1 sectors
```

```
OMAP1610 Innovator # erase 0 1FFFF
```

```
. done
```

```
Erased 1 sectors
```

```
OMAP1610 Innovator # cp.b 10000000 0 15580
```

```
Copy to Flash... done
```

```
OMAP1610 Innovator #
```



Let's Try to Boot

- Copy kernel image to OSK at 0x10000000

```
OMAP5912 OSK # tftpbboot 10000000
```

```
  /home/pesos/images/uImage_bb.cc
```

```
Using MAC Address 00:0E:99:02:07:A4
```

```
TFTP from server 192.168.1.10; our IP address is  
  192.168.1.102
```

```
Filename '/home/pesos/images/uImage_bb.cc'.
```

```
Load address: 0x10000000
```

```
Loading:
```

```
#####
```

```
...
```

```
done
```

```
Bytes transferred = 940954 (e5b9a hex)
```



Booting (cont'd)

- Boot the kernel image from 0x10000000

```
OMAP5912 OSK # bootm 10000000
```

```
## Booting image at 10000000 ...
```

```
Image Name:      OE
```

```
Image Type:      ARM Linux Kernel Image (gzip  
compressed)
```

```
Data Size:       940890 Bytes = 918.8 kB
```

```
Load Address:    10c08000
```

```
Entry Point:     10c08000
```

```
Verifying Checksum ... OK
```

```
Uncompressing Kernel Image ... OK
```

```
...
```



Booting (cont'd)

...

Copying default qpe.conf into /home/root/Settings/

Starting Opie in 5 seconds... press key to interrupt.

Starting Opie....

ODevice() - found 'Hardware' : 'TI-OSK'

...

<unknown>: setting QWS_DISPLAY to
'Transformed:Rot0:0'

qt_init() - starting in daemon mode...

OpenEmbedded Linux omap5912osk ttyS0

omap5912osk login:



Booting (cont'd)



June 13th, 2005



Booting (cont'd)

- But

```
omap5912osk login: root
```

```
login: cannot set groups: Operation not  
permitted
```

```
OpenEmbedded Linux omap5912osk ttyS0
```

```
omap5912osk login:
```



Booting (cont'd)

- Try again, but simpler
 - \$ `bitbake bootstrap-image`
- Only build pieces necessary to boot
 - Command line operations
 - Root file system for NFS mount
 - busybox
 - no GUI



Login Solution

- Tinylogin is being used
 - Tinylogin web site and the Makefile have suggestions
 - They don't make a difference
- Put in lots of debug writes in Tinylogin
- The cause of the problem:

In file `kernel/sys.c` function `sys_setgroups()`

```
if (!capable(CAP_SETGID))  
    return -EPERM;
```

- `capable()` is in `include/linux/sched.h`



Login Solution (cont'd)

- Put debug writes in kernel
- The problem is in `sys_setgid` (obviously!)
- Aside: how to compile only a kernel



Compiling New Kernel

```
$ cd build/tmp-5912osk/stamps/  
$ rm linux-omap1-2.6.12-rc2.do_compile  
$ rm linux-omap1-2.6.12-rc2.do_populate_staging  
$ rm linux-omap1-2.6.12-rc2.do_package  
$ rm linux-omap1-2.6.12-rc2.do_deploy  
$ bitbake linux-omap1
```

- Removing `do_configure` may cause a problem



Login Solution (cont'd)

```
$ ls -l tmp-omap5912osk/rootfs/bin/tinylogin
-rwsr-xr-x  1 pesos pesos 39328 Jun  2 08:26 tinylogin
$
```

- It's suid and owner/group are pesos
- Solution

```
$ chmod 755 tinylogin
```

- It doesn't need to be suid
- Now we can log in!



Touch Screen Problem

- “Tap anywhere” doesn’t do anything
- Login problem and touch screen problem are unrelated
- Now we have a console window where we can diagnose the problem better



Touch Screen Solution

- <http://oskfordummies.hp.infoseek.co.jp/> has information on setting up touch screen
- It uses tslib
- tslib is in OpenEmbedded, but not linked into qte
- Recompile qte with QT_QWS_TSLIB defined



Touch Screen Solution (cont'd)

- Edit packages/qte/qte_2.3.10.bb to include tslib as part of qte configuration

- Change

```
EXTRA_OECONF = "-system-jpeg -system-libpng ...
```

to

```
EXTRA_OECONF = "-tslib -system-jpeg ...
```

- Rebuild qte
 - Remove relevant qte* files from build/tmp/stamps
 - bitbake opie-image



rootfs Problem and Solution

- First login initialized many files
- They are owned by root
- Can't make new rootfs as a “normal” user
- A (simple) solution
 - Remove rootfs directory before running bitbake



Touch Screen Problem Continues

- Still no touch screen
- "od -vx /dev/input/event1" prints out things – that's good
- In file `qte-2.3.10-r16/qt-2.3.10/src/kernel/qwsmouse_qws.cpp`

```
if((tsdevice = getenv("TSLIB_TSDEVICE")) != NULL) {  
    m_ts = ts_open( tsdevice, 1 );  
} else {  
    m_ts = ts_open( "/dev/ts", 1 );  
}
```

- So define TSLIB_TSDEVICE



Still Doesn't Work

- Lots of debug prints in qte startup
- daemon mode isn't starting correctly
- There's a command line `-nodaemon` option
- In `rootfs/etc/init.d/opie`

- Change appropriate line to

```
$SSHAGENT $OPIEDIR/bin/qpe -nodaemon -  
terminal 2 &
```



62



Finished – sort of



June 13th, 2005



OpenEmbedded Size

- Initial download: 235 MB
- tmp directory: 4.4 GB
 - work: 3.8 GB
 - rootfs: 36 MB
- Be careful – it grows, especially CVS packages



CVS Packages

```
$ du -sh work/tmp-omap5912osk/libopie2*
21M      libopie2-1.2.0+cvs-20050520-r0
21M      libopie2-1.2.0+cvs-20050523-r0
21M      libopie2-1.2.0+cvs-20050601-r0
$ ls ~/downloads/opie.libopie2*
opie.libopie2_cvs.handhelds.org__20050329.tar.gz
opie.libopie2_cvs.handhelds.org__20050330.tar.gz
opie.libopie2_cvs.handhelds.org__20050331.tar.gz
...
opie.libopie2_cvs.handhelds.org__20050520.tar.gz
opie.libopie2_cvs.handhelds.org__20050523.tar.gz
opie.libopie2_cvs.handhelds.org__20050601.tar.gz
```

18 of them!



Disadvantages

- Can be difficult to use automatically generated tool chain for external project
- Two sources for bugs
 - Meta files
 - Code bugs
- Frequently, waiting a day can fix a problem
 - Just do “bk pull” and try again
 - If not, post to appropriate mailing list
 - Not everyone is using your configuration



Disadvantages (cont'd)

- Just before major release, files undergoing tremendous changes
- If a version works, keep it for a while (or save it)
- The size of the sources can sneak up on you



Advantages

- Easy to use
- Tool chain built automatically
- Gets and merges appropriate patches
- Multiple distributions and boards and kernels
 - 49 boards (openembedded/conf/machine)
 - 25 distributions (openembedded/conf/distros)
 - Various 2.4 and 2.6 kernels
 - User level GUIs



OpenEmbedded URLs

- OpenEmbedded home page
 - <http://openembedded.org/>
- OpenEmbedded mailing lists
 - <http://www.oesf.org/forums/>
- OpenEmbedded wiki front page
 - <http://openembedded.org/cgi-bin/moin.cgi/FrontPage>
- How to build OpenEmbedded
 - <http://openembedded.org/cgi-bin/moin.cgi/GettingStarted>



OSK URLs

- OMAP kernel code
 - <http://linux.omap.com/pub/>
- OMAP mailing list
 - <http://linux.omap.com/pipermail/linux-omap-open-source/>
- OMAP patches for various Linux kernel versions
 - <http://linux.omap.com/pub/patches/www.muru.com.mirror/>
- A main site for Linux OMAP
 - <http://www.muru.com/linux/omap/>



OSK URLs (cont'd)

- OSK for dummies
 - <http://oskfordummies.hp.infoseek.co.jp/index.html>
- Description of OSK board with some links
 - <http://tree.celinuxforum.org/CelfPubWiki/OSK>
- Spectrum Digital OSK catalog page
 - http://www.spectrumdigital.com/cgi/catalog.cgi?show_product=701875
- Mistral Software OSK LCD catalog page
 - http://www.mistralsoftware.com/html/product/omap_products/products-omap5912_starterkit.php



OSK URLs (cont'd)

- TI page for Linux OMAP downloads
 - http://focus.ti.com/docs/general/splashdsp.jhtml?&path=templatedata/cm/splashdsp/data/linux_com_downloads
- TI page for OSK
 - http://focus.ti.com/docs/toolsw/folders/print/tm_dxosk5912.html



Conclusions

- OSK
 - Designed with CE in mind
 - Full featured development system
 - Inexpensive
 - Lots of support from community
- OpenEmbedded
 - Easy to use
 - Community support
 - Not difficult to add/modify simple packages
 - Overall, well done and worth serious consideration